

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2022/2023

PPH0036 – MODERN PHYSICS AND THERMODYNAMICS

(Foundation in Engineering)

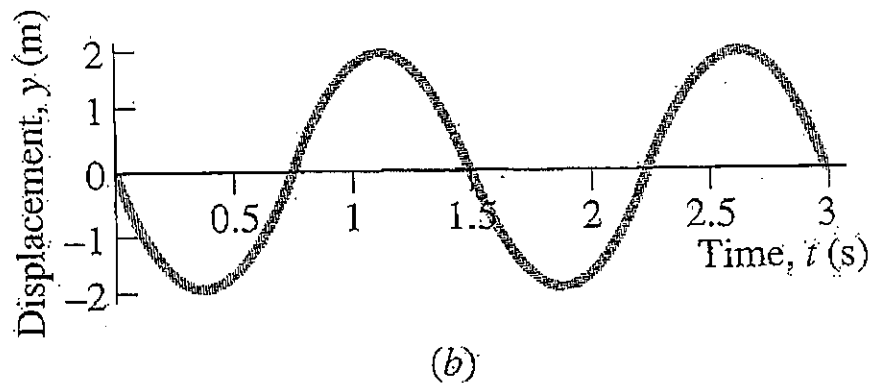
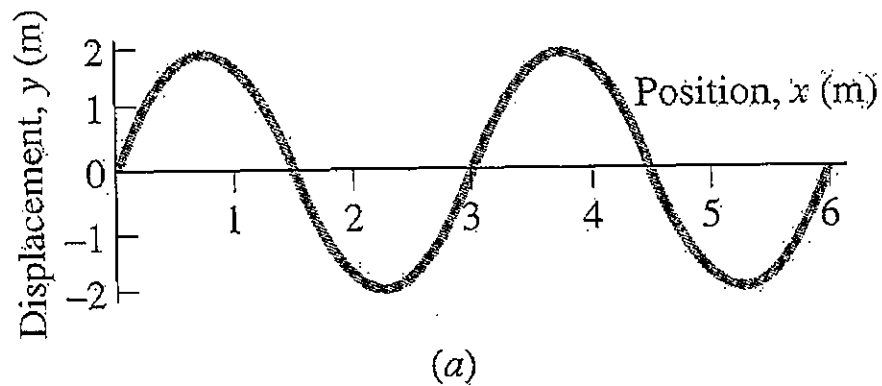
2 OCTOBER 2023
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages (excluding the cover page) with 5 structured questions.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

Question 1 [10 marks]

- (a) What is wave? [1 mark]
- (b) Figure Q1 shows two graphs that represent a transverse wave on a string. Determine an equation that describe the wave. [4 marks]

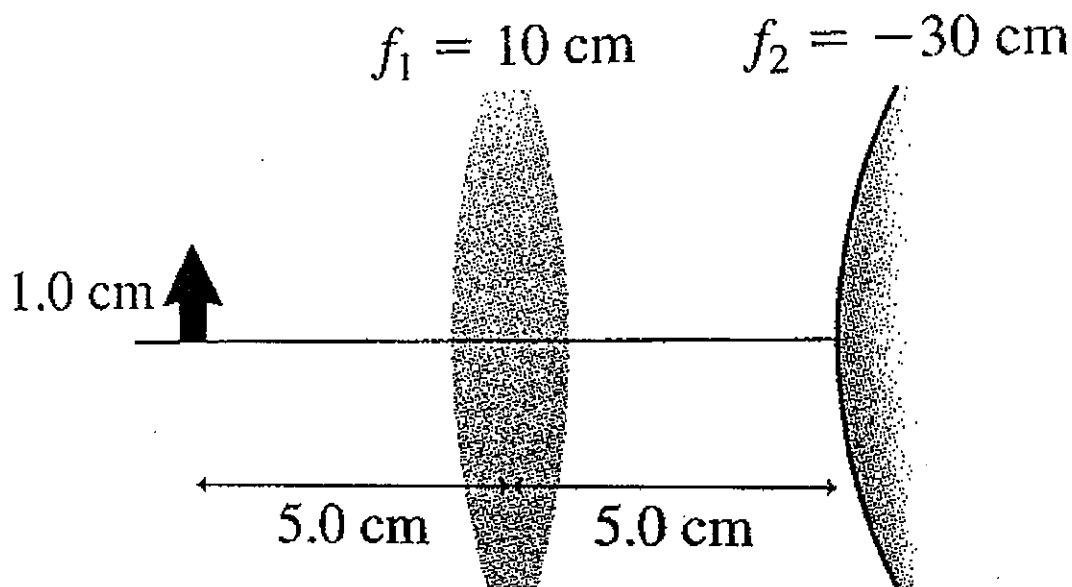
**Figure Q1**

- (c) Sound waves are produced by _____. [1 mark]
- (d) A jet plane in an air show emits sound uniformly in all directions, radiating an acoustic power of $2.25 \times 10^5 \text{ W}$.
- (i) How high is the jet plane from an observer on ground who perceive 82.53 dB? [2 marks]
- (ii) What frequency is perceived by the observer if the jet emitting a frequency of 3500 Hz, flies away from him at a speed of 333 m/s? [2 marks]

Continued...

Question 2 [10 marks]

- (a) A fisherman is standing on the bank of a lake. To the fisherman, the fish in the lake appear to be _____ to the water surface. [1 mark]
- (b) A 1.0-cm-high object is located 5.0 cm to the left of a converging lens of focal length $f_1 = 10$ cm (Figure Q2). A convex mirror of focal length $f_2 = -30$ cm is located 5.0 cm to the right of the lens. What is the position of the final image from the lens? [4 marks]

**Figure Q2**

- (c) A single slit diffraction pattern arises because different points along a slit create wavelets (according to Huygen's principle) that _____ with each other just as a double slit would. [1 mark]
- (d) A monochromatic light of wavelength 500 nm is used in a Young's double slits experiment. The fringe separation is 0.75 mm and the distance between the screen and the slits is 1.80 m.
- (i) Calculate the distance between the two slits. [2 marks]
- (ii) If one of the slits is covered, a single slit diffraction pattern is observed and the width of the central maximum is 1.0 cm. Determine the width of the single slit. [2 marks]

Continued...

Question 3 [10 marks]

- (a) What is meant by photoelectric effect? [1 mark]
- (b) The work function of zinc is 4.31 eV.
- (i) What is meant by the work function of zinc is 4.31 eV? [1 mark]
- (ii) Determine whether the visible light (400 nm ~ 700 nm) can eject electrons from zinc. [3 marks]
- (iii) If photons of energy 5.50 eV are incident on zinc, what is the maximum speed of the ejected photoelectrons? [3 marks]
- (c) Figure Q3(c) shows the lowest three energy levels of a hydrogen atom. Excited hydrogen atoms can emit light of wavelength 656 nm. By means of a calculation determine which electron transition emits this photon. [2 marks]

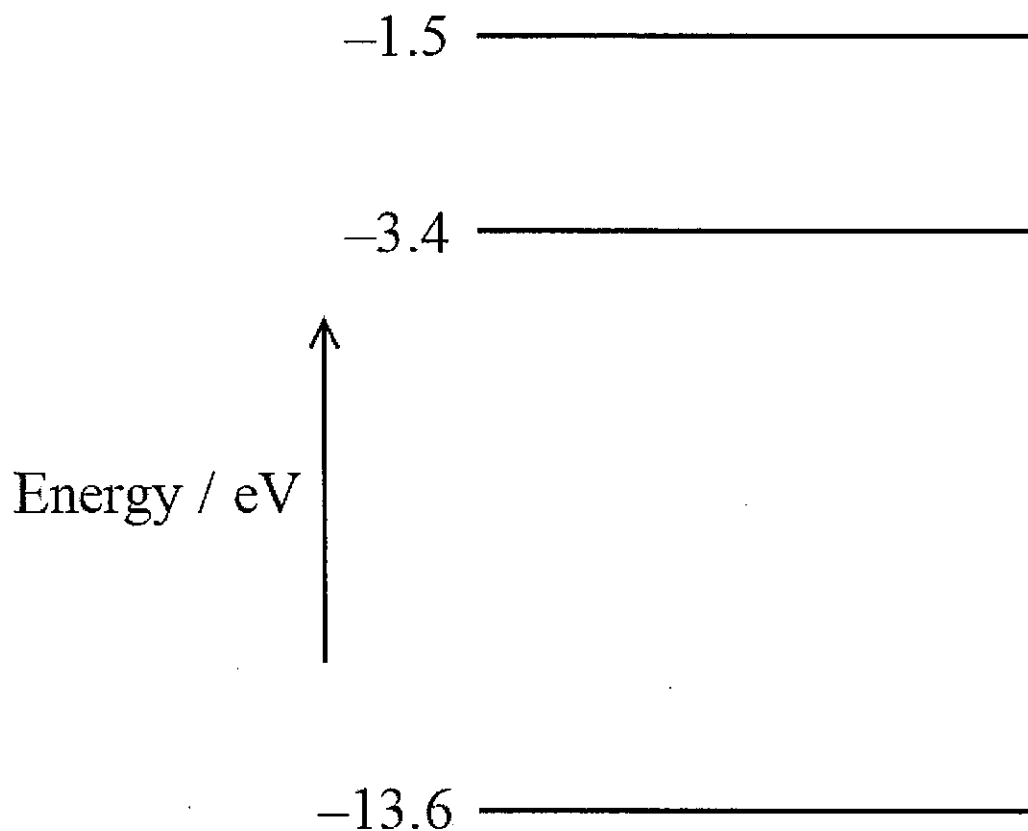


Figure Q3(c)

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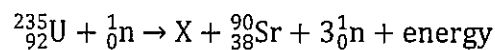
Question 4 [10 marks]

- (a) The decay constant of a radioisotope is $2.80 \times 10^{-8} \text{ s}^{-1}$. A sample of the isotope contains 5.66×10^{22} atoms.

(i) Calculate the half-life of the radioisotope. [2 marks]

(ii) How many atoms of the isotope in the sample have decayed in one year? [3 marks]

- (b) A slow neutron produces the reaction when absorbed by a ${}^{235}_{92}\text{U}$ nucleus:



(i) Identify the type of reaction represented by the above equation. [1 mark]

(ii) Determine X. [1 mark]

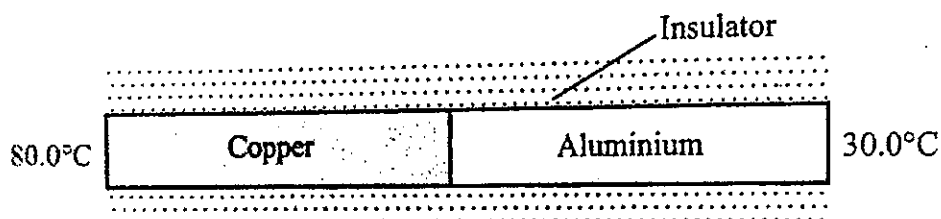
(iii) Calculate the energy released. Given that the atomic mass of ${}^{235}_{92}\text{U} = 235.043928 \text{ u}$, ${}^1_0\text{n} = 1.008665 \text{ u}$, $\text{X} = 142.935369 \text{ u}$ and ${}^{90}_{38}\text{Sr} = 89.907727 \text{ u}$. [2 marks]

(iv) State the feature of this equation that indicates that a chain reaction may be possible. [1 mark]

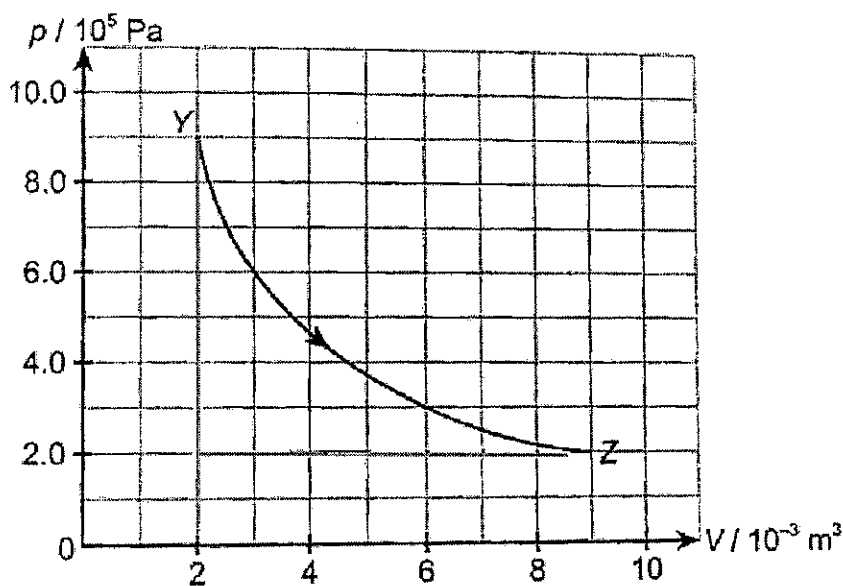
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Question 5 [10 marks]

- (a) Two rods, a copper and an aluminum, of equal length and cross-sectional area are joined together and perfectly insulated as shown in Figure Q5(a). The temperatures at the open ends of the copper and aluminum are 80.0°C and 30.0°C respectively. [The thermal conductivity of the copper and aluminum are $401 \text{ J}/(\text{sm}^{\circ}\text{C})$ and $235 \text{ J}/(\text{sm}^{\circ}\text{C})$ respectively.]

**Figure Q5(a)**

- (i) State the heat transfer process in the rods. [1 mark]
- (ii) Calculate the temperature at the interface of the two rods. [3 marks]
- (b) 1 mole of an ideal gas undergoes the thermodynamic process shown in Figure Q5(b).

**Figure Q5(b)**

- (i) Calculate the temperature at point Y and Z. [3 marks]
- (ii) State the thermodynamic process YZ. [1 mark]
- (iii) Calculate the work done from point Y to point Z. [2 marks]

End of Page

Physical Constants

Acceleration due to gravity	g	$= 9.8 \text{ m s}^{-2}$
Speed of Sound in Air	v	$= 343 \text{ m s}^{-1}$
Speed of light in vacuum	c	$= 3 \times 10^8 \text{ m s}^{-1}$
Threshold of hearing	I_0	$= 1.0 \times 10^{-12} \text{ W m}^{-2}$
Electronic charge	e	$= 1.602 \times 10^{-19} \text{ C}$
Electron mass	m_e	$= 9.11 \times 10^{-31} \text{ kg}$
Proton mass	m_p	$= 1.6726 \times 10^{-27} \text{ kg}$
Neutron mass	m_n	$= 1.6749 \times 10^{-27} \text{ kg}$
Refractive index of air/vacuum	n	$= 1.0$
Wein's displacement constant		$= 0.2898 \times 10^{-2} \text{ m.K}$
Planck's constant	h	$= 6.626 \times 10^{-34} \text{ J. s}$
Rydberg constant	R_H	$= 1.097 \times 10^7 \text{ m}^{-1}$
Avogadro's Number	N_A	$= 6.02 \times 10^{23} \text{ mol}^{-1}$
Unified atomic mass unit	1 u	$= 1.66 \times 10^{-27} \text{ kg}$
	1 eV	$= 1.602 \times 10^{-19} \text{ J}$
Stefan-Boltzmann constant	σ	$= 5.67 \times 10^{-8} \text{ J s}^{-1} \cdot \text{m}^{-2} \cdot \text{K}^{-4}$
Universal gas constant	R	$= 8.31 \text{ J mol}^{-1} \cdot \text{K}^{-1}$
Boltzmann's constant	k	$= 1.38 \times 10^{-23} \text{ J K}^{-1}$
	1 atm	$= 1.013 \times 10^5 \text{ Pa}$

The energy equivalent of the atomic mass unit is 931.5 MeV

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Formula List

$$\sin \theta_1 + \sin \theta_2 = 2 \sin \frac{1}{2} (\theta_1 + \theta_2) \cos \frac{1}{2} (\theta_1 - \theta_2)$$

$$\cos \theta_1 + \cos \theta_2 = 2 \cos \frac{1}{2} (\theta_1 + \theta_2) \cos \frac{1}{2} (\theta_1 - \theta_2)$$

$$\sin \left(\theta + \frac{\pi}{2} \right) = \cos \theta$$

$$\sin \theta \approx \tan \theta \approx \theta \text{ rad for small angle}$$

$$D(x, t) = D_M \sin(kx \pm \omega t \pm \phi)$$

$$v = \sqrt{\frac{F_r}{\mu}}$$

$$\lambda_n = \frac{2}{n} L$$

$$v = \sqrt{\frac{\text{elastic property of the medium}}{\text{inertia property of the medium}}}$$

$$f' = f \left(\frac{v \pm v_o}{v \mp v_s} \right)$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$\frac{1}{f} = (n - 1) \left\{ \frac{1}{R_1} + \frac{1}{R_2} \right\}$$

$$d \sin \theta = m \lambda$$

$$d \sin \theta = \left(m + \frac{1}{2} \right) \lambda$$

$$\lambda_m T = 0.2898 \times 10^{-2}$$

$$\lambda = \frac{h}{p}$$

$$E_n = -\frac{mk^2 e^4}{2\hbar^2} \left(\frac{1}{n^2} \right)$$

$$r_n = \frac{\hbar^2}{mke^2} n^2$$

$$L = mvr_n = n\hbar$$

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right]$$

$$\frac{1}{\lambda} = \frac{mk^2 Z^2 e^4}{4\pi c \hbar^3} \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right]$$

$$R = R_0 e^{-U}$$

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

$$\frac{\Delta Q}{\Delta t} = -kA \frac{\Delta T}{\Delta L}$$

$$\frac{\Delta Q}{\Delta t} = e\sigma AT^4$$

$$\frac{\Delta Q}{\Delta t} = IeA \cos \theta$$

$$pV = nRT$$

$$k = \frac{R}{N_A}$$

$$Q = (M_x - M_y - M_a) c^2$$

$$\overline{KE} = \frac{1}{2} m \bar{v}^2 = \frac{3}{2} kT$$

$$U = \frac{3}{2} RT$$

$$Q = \Delta U + W$$

$$W = \int dW = \int_{V_i}^{V_f} P dV$$